

2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.
4. El-Mansi, E.M.T., Bryce, C.F.A., Ddemain, A.L., Allman, A.R., Fermentatias Microbiology and Biotechnology, 2nd Ed. Taylor & Francis.
5. Prescott & Dunn's Industrial Microbiology, 2004, CBS Publisher.

Semester-II

Chemistry MAJOR

Paper code: CHEM2011

Paper title: Basic Chemistry-II

Credit 3 + 1

Theory

Credit 3

Course objective

- Several basic topics from inorganic, organic and physical chemistry have been chosen for the development of the general chemistry knowledge of the students.
- This will help to grow the foundation for studying the several aspects of applied chemistry in future.

Course outcome

The topics will grow the foundation of the students for the subject chemistry for learning any further advanced topics.

*Dr. Snehasis Banerjee, WBES
Associate Professor
Hooghly Mohsin College
sbanchem@gmail.com*

1. Chemical bonding-I

Ionic bond: general characteristics, types of ions, size effects, radius ratio rule and its application and limitations, packing of ions in crystals Born-Landé equation with derivation and importance, Kapustinskii expression for lattice energy, Madelung constant, Born-Haber cycle and its application, solvation energy, solubility energetics of dissolution process.

Covalent bond: polarizing power and polarizability, ionic potential, Fajan's rules, Lewis structures, formal charge, Valence Bond Theory- hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, dipole moments, VSEPR

theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach)

6 Hours

2. Redox Reactions and Precipitation Reactions

Balancing of redox reactions: ion-electron method, elementary idea on standard redox potentials- Nernst equation (without derivation), influence of complex formation, precipitation and pH, formal potential

Redox titrations: feasibility, redox potential at the equivalence point, redox indicators, redox potential diagram (Latimer and Frost diagrams) of common elements and their applications Disproportionation and comproportionation reactions (typical examples), solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides

4 Hours

3. Stereochemistry-I

Bonding geometries and representation of carbon compounds: tetrahedral nature of carbon and concept of asymmetry: Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations

Chirality and symmetry: symmetry elements and point groups (C_v , C_{nv} , C_{nh} , C_n , D_h , D_{nh} , D_{nd} , D_n , S_n (C_s , C_i), molecular chirality and centre of chirality, asymmetric and dissymmetric molecules, enantiomers and diastereomers, epimers, stereogenicity, chirotopicity and pseudoasymmetry, chiral centres and number of stereoisomerism, systems involving 1/2/3-chiral centre(s)- AA, AB, ABA and ABC types

Relative and absolute configuration: D/L and R/S descriptors, erythro/threo and meso nomenclature of compounds, syn/anti nomenclatures for aldols, E/Z descriptors- C=C, conjugated diene, triene, C=N and N=N systems, combination of R/S- and E/Z-isomerisms

Optical activity compounds: optical rotation, specific rotation and molar rotation, racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates), resolution of acids, bases and alcohols via diastereomeric salt formation, optical purity and enantiomeric excess.

6 Hours

4. General Treatment of Reaction Mechanism

Free energy profiles: one-, two- and three-step reactions, catalyzed reactions- electrophilic and nucleophilic catalysis, kinetic control and thermodynamic control of reactions, isotope effect- primary and secondary kinetic isotopic effect (k_H/k_D), principle of microscopic reversibility

Tautomerism: prototropy (keto-enol, amido-imidol, nitroso-oximino, diazo-amino and enamine-imine systems) and ring-chain tautomerism, composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism, application of thermodynamic principles in tautomeric equilibria

6 Hours

5. Substitution and Elimination Reactions

Nucleophilic substitution reactions: substitution at sp^3 centre- mechanisms (with evidence), relative rates, stereochemical features, S_N^1 , S_N^2 , S_N^2' , S_N^1' (allylic rearrangement) and S_N^i , effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite), electrofuges and nucleofuges, substitutions involving NGP, role of crown ethers and phase transfer catalysts [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides]

Elimination reactions: E_1 , E_2 , E_{1cB} and E_i (pyrolytic syn eliminations), formation of alkenes and alkynes, mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity, comparison between substitution and elimination

6 Hours

6. Kinetic Theory of gases:

Concept of pressure and temperature; collision of gas molecules, collision diameter, collision number and mean free path, frequency of binary collisions (similar and different molecules), wall collision and rate of effusion

Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions, kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case, calculation of number of molecules having energy $\geq \epsilon$, equipartition principle and its application to calculate

the classical limit of molar heat capacity of gases.

5 Hours

7. Liquid state

Viscosity: General features of fluid flow (streamline and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method; temperature variation of viscosity of liquids and comparison with that of gases

Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; work of cohesion and adhesion, spreading of liquids over other surfaces; vapour pressure over curved surface; temperature dependence of surface tension, principle of surface tension measurement

6 Hours

8. Thermodynamics-II

Second Law: its need and statement, concept of heat reservoirs and heat engines, Carnot cycle, physical concept of entropy, Carnot engine and refrigerator, Kelvin – Planck and Clausius statements and their equivalence in entropic formulation, Carnot's theorem, values of $\int dQ/T$ and Clausius inequality, entropy change of systems and surroundings for various processes and transformations, entropy and unavailable work, auxiliary state functions (G and A) and their variations (with T, P and V), criteria of spontaneity and equilibrium

Thermodynamic relations: Maxwell's relations, Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences, inversion temperature, Joule-Thomson coefficient for a van der Waals gas, general heat capacity relations.

6 Hours

Reference Books

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
4. Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P.L., Basic Inorganic Chemistry 3rd Ed.; Wiley India.
6. Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
8. Mingos, D.M.P., Essential trends in inorganic chemistry. Oxford University Press (1998).

9. Winter, M. J., The Orbitron, <http://winter.group.shef.ac.uk/orbitron/> (2002). An illustrated gallery of atomic and molecular orbitals.
10. Burgess, J., Ions in solution: basic principles of chemical interactions. Ellis Horwood (1999).
11. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
12. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
13. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
14. Pathak & Saha, Organic Chemistry (Volume-1), Books and Allied (P) Ltd.
15. Rajaram, J. Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson.
16. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
17. Morrison, R. T. Study guide to organic Chemistry, Pearson.
18. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press.
19. Castellan, G. W. Physical Chemistry, Narosa Publishing House.
20. Maron, S. & Prutton, Principles of Physical Chemistry, Collier Macmillan Ltd.
21. Laidler, K. J. Chemical Kinetics, Pearson.
22. Glasstone, S. & Lewis, G.N. Elements of Physical Chemistry.
23. Rakshit, P.C., Physical Chemistry, Sarat Book House.
24. Rastogi, R. P. & Misra, R.R. An Introduction to Chemical Thermodynamics, Vikas.
25. Sharma, K. K. & Sharma, L. K., A Textbook of Physical Chemistry, Vikas Publishing House.
26. Nasipuri, D. Stereochemistry of Organic Compounds, New Age International (P) Ltd.
27. Sengupta, S. Basic Stereochemistry of Organic Molecules, Oxford University Press
28. Manna, A.K. Organic Molecular Spectroscopy, Books and Allied (P) Ltd.
29. Bajpai, D. N., Advanced Physical Chemistry, S. Chand Publication.
30. Engel, T. & Reid, P. Physical Chemistry, Pearson.
31. Levine, I. N. Physical Chemistry, Tata McGraw-Hill.
32. Ball, D. W. Physical Chemistry, Thomson Press.
33. Chatterjee Hrishikesh, Physical Chemistry (Volume-1), Platinum Publisher
34. Kapoor, K.L., Textbook of Physical Chemistry (Volume 1 and Volume-2), McGraw Hill Education
35. Ghoshal, A. Numerical problems & short questions on Physical Chemistry, Books and Allied (P) Ltd.

Practical

Credit 1

1. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate
2. Study of kinetics of decomposition of H_2O_2 by KI

3. Determination of pH of unknown strong alkali and acid solution by colour matching method
4. Determination of pH of unknown buffer solution by colour matching method
5. Study of viscosity of unknown liquid (glycerol, sugar) with respect to water
6. Determination of surface tension of a liquid using Stalagmometer

15 Hours

Reference Books

1. Bhattacharyya, R. C, A Manual of Practical Chemistry.
2. Nad, Mahapatra, Ghosal, An Advance course in Practical Chemistry, New Central Book Agency (P) Ltd.
3. K. S. Mukherjee, Textbook on Practical Chemistry, New Central Book Agency (P) Ltd.
4. Ghosh, Das Sharma, Majumdar, Manna, Chemistry in Laboratory, santra Publication (P) Ltd.
5. Poddar and Ghosh, Degree Practical Chemistry, Book Syndicate (P) Ltd.

Chemistry MINOR

Paper code: CHEM2021

Paper title: General Chemistry-II

Credit 3 + 1

Theory

Credit 3

Course objective

- Several basic aspects from inorganic, organic and physical chemistry have been discussed
- Generation of idea for studying physical and biological sciences in future

Course outcome

The idea created from this course may help to understand students for further studying physical, biological and material sciences.

1. Thermodynamics-II

Statement of the second law of thermodynamics, concept of heat reservoirs and heat engines, Carnot cycle, physical concept of entropy, Carnot engine, refrigerator and efficiency, entropy change of systems and surroundings for various processes and transformations, auxiliary state functions (G and A) and criteria for spontaneity and equilibrium

5 Hours

2. Ideal gas

Collision of gas molecules, collision diameter, collision number and mean free path, frequency of binary collisions (similar and different molecules), rate of effusion

Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy, average velocity, root mean square velocity and most probable velocity, equipartition principle and its application to calculate the classical limit of molar heat capacity of gases.

5 Hours

3. Chemical Kinetics-II

Collision theory, Lindemann theory of unimolecular reaction, outline of Transition State theory (classical treatment)

5 Hours

4. Fundamentals of Organic Chemistry

Electronic displacement phenomena- inductive effect, resonance and hyperconjugation, cleavage of bonds- homolytic and heterolytic, structures of organic molecules on the basis of VBT, nucleophiles, electrophiles, reactive intermediates- carbocations, carbanions and free radicals.

6 Hours

5. Stereochemistry

Isomerism- geometrical and optical isomerism, concept of chirality and optical activity (up to two carbon atoms), asymmetric carbon atom, elements of symmetry (plane and centre), interconversion of Fischer and Newman representations, enantiomerism and diastereomerism, meso compounds, threo and erythro, D and L, cis- and trans- nomenclatures, CIP rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclatures.

6 Hours

6. Nucleophilic Substitution and Elimination Reactions

Nucleophilic substitutions- S_N^1 , S_N^2 and S_N^i reactions, eliminations- E_1 and E_2 reactions (elementary mechanistic aspects), Saytzeff and Hofmann eliminations, elimination vs. substitution

6 Hours

7. Chemical Bonding and Molecular Structure

Ionic Bonding: general characteristics, energy considerations, lattice energy and solvation energy and their importance for stability and solubility of ionic

compounds, statement of Born-Landé equation for lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajans' rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character

Covalent bonding: Valence Bond (VB) theory approach, shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements

Concept of resonance and resonating structures in various inorganic and organic compounds

Molecular orbital (MO) theory approach -the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods. (including the idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO⁺, comparison of VB and MO approaches

12 Hours

Reference Books

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
4. Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P.L., Basic Inorganic Chemistry 3rd Ed.; Wiley India.
6. Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
8. Mingos, D.M.P., Essential trends in inorganic chemistry. Oxford University Press (1998).
9. Burgess, J., Ions in solution: basic principles of chemical interactions. Ellis Horwood (1999).
10. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
11. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
12. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
13. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
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15. Pathak & Saha, Organic Chemistry (Volume-1), Books and Allied (P) Ltd.

16. Castellan, G. W. Physical Chemistry, Narosa Publishing House.
17. Engel, T. & Reid, P. Physical Chemistry, Pearson.
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24. Bajpai, D. N., Advanced Physical Chemistry, S. Chand Publication.
25. Rajaram, J. Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson.
26. Nasipuri, D. Stereochemistry of Organic Compounds, New Age International (P) Ltd.
27. Sengupta, S. Basic Stereochemistry of Organic Molecules, Oxford University Press
28. Chatterjee Hrishikesh, Physical Chemistry (Volume-1), Platinum Publisher
29. Kapoor, K.L., Textbook of Physical Chemistry (Volume 1 and Volume-2), McGraw Hill Education
30. Ghoshal, A. Numerical problems & short questions on Physical Chemistry, Books and Allied (P) Ltd.
31. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press.

Practical

Credit 1

1. Determination of pH of unknown strong alkali and acid by colour matching method
2. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate
3. Estimation of Mohr's salt by titrating with KMnO_4 / $\text{K}_2\text{Cr}_2\text{O}_7$
4. Estimation of sodium carbonate and sodium hydrogen carbonate in a mixture

15 Hours

Reference Books

1. Bhattacharyya, R. C, A Manual of Practical Chemistry.
2. Nad, Mahapatra, Ghosal, An Advance course in Practical Chemistry, New Central Book Agency (P) Ltd.
3. K. S. Mukherjee, Textbook on Practical Chemistry, New Central Book Agency (P) Ltd.
4. Ghosh, Das Sharma, Majumdar, Manna, Chemistry in Laboratory, santra Publication (P) Ltd.
5. Poddar and Ghosh, Degree Practical Chemistry, Book Syndicate (P) Ltd.

MULTIDISCIPLINARY

Paper code: CHEM2031

Paper title: Chemistry of Dyes, Pigments, Cosmetics and Perfumes Credit 3

Course objective

Introduction of idea of every day products of chemical industries

Course outcome

Development of idea of several molecules and materials related to dye and cosmetics industry

Theory

Definition and classification, structures and theories of coloration, preparation, properties and uses of dyes like phenolphthalein, methyl orange, malachite green, alizarin, indigo, different types of pigments like chlorophyll, carotenoids, anthocyanins, flavonoids (elemental idea)

Preparation and uses of the following: hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours

Essential oils and their importance in cosmetic industries with reference to eugenol, geraniol, sandalwood oil, eucalyptus, rose-oil, 2-phenyl ethyl alcohol, jasmone, civetone, muscone

*45 Hours***Reference Books**

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
2. Bahl and Bahl, A Text book of Organic Chemistry, S. Chand publication
3. StocchiE.: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
4. Jain, P.C.&Jain,M.:Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
5. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

SKILL ENHANCEMENT COURSE

Paper title: CHEM2051

Paper code: Basic Analytical Chemistry Credit 3

Course objective

- Development of skill for analyzing several natural and synthetic samples to find out their purity, composition, etc
- Development of skill for advanced separation techniques for natural and synthetic samples

Course outcome

This course will develop the analysis as well as separation skills of the students which may help them to motivate for joining research and/or have employment.

Theory

Credit 3

1. General principle

Introduction to analytical chemistry and its interdisciplinary nature, concept of sampling, importance of accuracy, precision and sources of error in analytical measurements, presentation of experimental data and results, role of significant figures

8 Hours

3. Analysis of soil

Composition of soil, concept of pH and pH measurement, complexometric titrations, chelation, chelating agents, use of indicators

6 Hours

3. Analysis of water

Definition of pure water, contaminants (different types), water sampling methods, water purification methods

6 Hours

4. Analysis of food products

Nutritional value of a food, idea about food processing and food preservations, and adulteration

6 Hours

5. Chromatography

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc., column chromatography, ion-exchange chromatography, etc., determination of ion exchange capacity of anion /cation exchange resin

10 Hours

6. Analysis of cosmetics

Major and minor constituents of cosmetics and their functions, analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate

9 Hours

Reference Books

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A., Holler, F.J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Analytical Chemistry: An Introduction sixth Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D. C. Quantitative Chemical Analysis, 9th ed. Macmillan Education, 2016.
5. Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992.
7. Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
8. Cooper, T.G. The Tools of Biochemistry, John Wiley & Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
10. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).
12. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

Semester-III

Chemistry MAJOR

Paper code: CHEM3011 (3 and 4 years)
 Paper title: Inorganic Chemistry (Theory)
 Credit: 5

Course objective

- Discussion of bonding theories (advanced parts)
- Application of the basic theories discussed so far towards coordination chemistry and s- and p-block elements